OBSERVATIONS AT HONOLULU.

Meteorological observations at Honolulu, Republic of Hawaii, by Curtis J. Lyons, Meteorologist to the Government Survey.

Pressure is corrected for temperature and reduced to sea level, but the gravity correction, —0.06, is still to be applied.
The absolute humidity is expressed in grains of water, per cubic foot, and is the average of four observations daily.
The average direction and force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 10.
The rainfall for twenty-four hours is given as measured at 6 a. m. on the respective dates.

June, 1895.	Pressure at sea level.			Temperature.					Humidity.			Wind.		Cloudiness.	Rain measured at 6 a. m.
	9 a. m.	3 p. m.	9 p. m.	6 a. m.	2 p. m.	9 p. m.	Maximum.	Minimum.	Relative. 9 a. m.	Relative. 9 p. m.	Absolute.	Direction.	Force.		
	Ins.	*Ins.*	*Ins.*	°	°	°	°	°	%	%					*Ins.*
1 ..	30.14	30.06	30.10	75	82	75	84	73	64	75	6.9	ne.	3	3-6	0.01
2 ..	30.08	30.02	30.09	72	79	75	80	70	78	72	7.2	ene.	3	8	0.09
3 ..	30.09	30.01	30.08	72	81	72	82	69	85	85	7.5	s.	1	8-3	0.00
4 ..	30.08	30.00	30.06	75	81	74	84	69	68	74	6.9	ne.	3-0	3	0.08
5 ..	30.05	29.99	30.07	74	81	74	84	70	63	85	7.0	nne.	2	2	0.01
6 ..	30.08	30.02	30.10	70	82	76	86	68	67	70	6.9	ene.	3	3	0.00
7 ..	30.10	30.04	30.13	73	78	75	82	71	70	70	7.0	ne.	3	4	0.00
8 ..	30.10	30.04	30.10	73	79	75	81	72	63	70	6.8	nne.	3	4	0.05
9 ..	30.10	30.04	30.07	71	78	73	81	70	80	80	7.2	ne.	3	8-3	0.10
10 ..	30.08	30.00	30.06	73	79	74	81	71	79	77	7.0	ene.	3	8-3	0.21
11 ..	30.05	29.99	30.05	72	80	75	83	69	66	70	7.0	ne.	4	2	0.09
12 ..	30.09	30.03	30.08	75	80	76	82	74	71	67	6.7	ene.	4	5	0.00
13 ..	30.13	30.04	30.10	75	78	75	81	74	72	74	6.8	ene.	4	6	0.00
14 ..	30.12	30.03	30.09	74	75	72	81	73	70	77	6.6	nne.	4	7	0.07
15 ..	30.07	30.00	30.05	72	77	74	80	70	67	70	6.6	ne.	4	5	0.29
16 ..	30.06	30.00	30.07	73	77	75	81	72	74	70	6.7	ne.	4	4	0.12
17 ..	30.09	30.04	30.10	73	81	76	83	72	62	67	6.6	ne.	4	3	0.08
18 ..	30.13	30.06	30.12	75	81	75	84	74	63	77	7.0	ne.	4	3	0.00
19 ..	30.12	30.05	30.10	73	78	74	80	72	70	67	6.7	ne.	5	5	0.11
20 ..	30.09	30.05	30.11	72	81	75	83	67	67	70	6.6	ene.	4	3-7	0.01
21 ..	30.09	30.07	30.14	73	79	75	84	70	67	74	6.7	ne.	3	4	0.00
22 ..	30.13	30.07	30.13	73	80	76	85	72	75	72	7.1	ne.	3	3	0.00
23 ..	30.13	30.07	30.14	75	80	76	85	71	71	68	7.2	ne.	3	4	0.08
24 ..	30.14	30.07	30.12	75	82	75	84	74	60	72	6.6	ne.	3	2	0.00
25 ..	30.11	30.04	30.00	69	82	75	84	67	62	74	6.8	ne.	3	3	0.00
26 ..	30.10	30.05	30.12	73	78	75	82	73	65	66	6.7	ne.	3	5	0.00
27 ..	30.08	30.04	30.06	73	78	75	81	71	64	70	6.3	nne.	5-8	7	0.00
28 ..	30.07	30.00	30.05	72	79	76	83	68	67	67	6.6	ne.	4	5	0.07
29 ..	30.08	30.04	30.10	72	80	76	81	71	74	70	7.0	ene.	4	5	0.03
30 ..	30.14	30.10	30.16	75	82	73	83	73	62	80	7.0	ne.	4	3	0.02
	30.10	30.03	30.10	73.0	79.6	74.7	82.5	71.0	68.9	72.7	6.9	....	......	......	1.52

The monthly summary for June is: Mean temperature, 76.7, or 0.5 above normal; extreme temperatures, 85.0 and 67.0: mean pressure, 30.07, or about normal; total rainfall, 1.52, or 5 per cent below normal.

FORECASTING MONSOON RAINS.

It has been the practice for the Meteorological Office of India, since 1885, to prepare annually, in June, a brief summary of the condition of the winter snowfall in the Himalayan and Afghan mountains, as also a statement of the peculiarities or abnormal features of the weather of India during the preceding months, January to May, inclusive, and, finally, to make a forecast of the probable character of the rains during the approaching southwest monsoon season. This forecast is not so much a prediction, based upon the laws of nature, as a statement of probabilities drawn from past experience, and simply means that apparently the chances in favor of any event that is predicted as probable are at least as large as 10 to 4, and, when very probable, as 10 to 2; that is to say, 71 and 83 per cent.

According to the memorandum for the current year, published at Simla on June 3, 1895, the chief features or conditions that determine the extension and general strength of the southwest monsoon current are (1) the amount and date of the cold weather snowfall in the mountain districts bordering northern India; (2) the local peculiarities of the weather in India itself immediately antecedent to the advance of the monsoon currents from the coasts in to the interior; these abnormal features are, on the whole, best estimated by the departures of barometric pressures from normal values in different parts of India; (3) local peculiarities of the weather over the Bay of Bengal and the Arabian Sea, over which the monsoon currents pass before they reach India.

With regard to the first of these, viz, the snowfall data in the mountainous regions during the winter of 1894–'95, the total for the year has been light, and the accumulation at the end of May, 1895, much smaller than for May, 1894. With regard to the second item, viz, the abnormal features of Indian weather, it is noted that there was an abnormal distribution of the snowfall; a corresponding abnormal pressure and temperature connected with the distribution of snow in the western Himalayas; a prevalence of more disturbed weather than usual in March and April, followed by very hot weather in May over the whole of India. With regard to the third item, viz, the weather over the Bay of Bengal, not much useful information had been received up to date, but the meteorological conditions were less favorable for a strong monsoon than they were in 1894.

By a comparison of the past twenty-six years some resemblances were found between corresponding seasons of the present and past years. The year 1893 was the coldest on record in India, and the rainfall was much greater than in any preceding year. The figures show that during the past five years India has gone through a period of heavy rainfall, such as it has not experienced for at least thirty years. The annual anomalies of rainfall are shown in the following table:

Annual rainfall in India.

Year.	No. of provinces that reported the rainfall as being— Excessive.	Normal.	Deficient.	Average departure from the normal for the Indian area only. Excess.	Deficiency.	Year.	No. of provinces that reported the rainfall as being— Excessive.	Normal.	Deficient.	Average departure from the normal for the Indian area only. Excess.	Deficiency.
				Inches.	*Inches.*					*Inches.*	*Inches.*
1864...	4	.....	16	....	—5.52	1880..	13	1	10	....	—1.56
1865...	8	1	11	....	—0.77	1881..	15	.....	9	+0.10	....
1866...	6	.....	14	....	—2.09	1882..	17	1	6	+2.64	....
1867...	8	2	10	+2.77	....	1883..	11	1	12	....	—0.12
1868...	5	.....	16	....	—6.63	1884..	12	.....	10	+1.49	....
1869...	8	1	13	+0.40	....	1885..	15	.....	7	+1.17	....
1870...	14	.....	10	+1.49	....	1886..	14	.....	8	+2.77	....
1871...	12	1	11	+0.93	....	1887..	11	.....	11	+2.04	....
1872...	14	3	7	+2.31	....	1888..	10	.....	12	....	—1.13
1873...	3	1	20	....	—4.46	1889..	15	.....	8	+1.92	....
1874...	15	3	6	+4.64	....	1890..	14	1	8	+0.46	....
1875...	16	.....	8	+2.38	....	1891..	6	.....	17	....	+0.30
1876...	6	.....	18	....	—4.49	1892..	15	.....	8	+4.55	....
1877...	10	.....	14	....	—4.28	1893..	22	.....	1	+8.94	....
1878...	17	1	6	+6.34	....	1894..	17	.....	6	+6.48	....
1879...	16	2	6	+1.69	....						

After a full statement of the prevailing conditions, Mr. Eliot concludes that it is probable that the monsoon currents during 1895 will be of normal strength, and that the monsoon of Bengal Bay is more likely to be above its normal strength than that of Bombay. The Bombay current is more likely to be retarded as to the time when it sets in than the Bengal current, but both will set about the normal time. As to the monsoon rains the general conclusion is—

That the rainfall may be deficient to a slight or moderate extent in Sind, Cutch, the southwest and central Punjaub, and west Rajputana; that it will very probably be at least normal in amount in the northern half of the peninsula, central India, east Rajputana, the east Punjaub, the greater part of the northwestern provinces, Bihar, Chota Nagpur, and perhaps Burma, and may be in moderate excess in the Gangetic plain and central India.

NOTE.—As the editor has said on a previous occasion, the southwest monsoon of India is a part of such a large movement of the atmosphere that he can not think that the variations in its strength and time of occurrence are determined to any important extent by the so-called local weather conditions of previous months prevailing over India and its immediate borders, but must rather consider these winter conditions and the following summer monsoon to be alike dependent upon much larger factors in the general circulation of the atmosphere.

The hot soil and heated air of the mountains and plateaus of south-central Asia contribute to the establishment of an indraught during the northern summer that is properly described as a swirl or quasi-cyclonic circulation about southern Siberia and the high land of Thibet and Mongolia. The strong southwest current that is thus drawn over India owes its existence to a push depending upon a denser air and higher pressure over the ocean to the southward; to the study of this fundamental feature Mr. J. Eliot, as the chief of the Meteorological Service of India, has devoted all possible attention. The variations from year to year in the character of the monsoon must depend quite as much on the conditions south of India as on those to the northward, and both of these must depend on the general atmospheric circulation. The southwest monsoon, when at its height in July, begins far to the southwest of India, and sweeps the Indian Ocean, the Arabian Sea, and the Bengal Sea, before striking the coasts of India and Burmah. Showers are frequent over the ocean, but the special rainfall begins on the coast and extends inward beyond the crests of the Malabar coast. After passing this maximum region the air descends over the Deccan, and the quantity of rain that falls in the interior of India from the monsoon current gradually diminishes as we proceed from the coast of Bombay (or of Burmah) northeastward, but again increases as we reach the Himalayas. Near the coast, where a general rise occurs in the course of the southwest monsoon, the precipitation descends as a general rain, but farther on as the current penetrates the interior, the rainfall is broken up into local rains and finally into isolated thundershowers. Now, rainfall depends essentially upon the quantity of moisture in the air and the rate of its cooling by ascent. At the beginning of the course of the monsoon over the ocean there is much moisture and but little ascent; when the current strikes the coast there is a rapid ascent and heavy rainfall; farther on, as the moisture diminishes and the air descends and the hot dry air of the interior is mixed with it, much greater or more violent ascents are necessary, and the air must be either pushed up to the crests of great atmospheric waves, or must be whirled up, as in the thunderstorm and tornado, to great heights, in order to produce abundant rain or possibly only heavy hail. Thus the diminution of rain as we proceed inward from the ocean may be described as partly the result of the diminishing moisture, but especially of the diminishing interaction between the ground, or the lower air at the surface of the ground, and the southwest monsoon overhead.

The desirability and importance of long range predictions, especially for "the growing season," can not be overestimated. If we would apply to the United States the results of experience in India, and attempt to make such predictions here, we have to bear in mind the following special conditions:

The Arabian Sea, Hindostan, the Bay of Bengal and Farther India, cover a region between the fifth and twenty-fifth parallels of north latitude, extending about 3,500 miles east and west, over which northeast winds prevail in January and February, but southwest winds in June, July, August, and September. These summer winds represent a swirl or a modified cyclonic whirl due to an indraught from the unbroken area of the Indian Ocean to the southward. The effect of any slight obstruction such as that of an island or coast range, is very quickly seen in the distribution of wind and rain. If the United States were as large as Asia, and had a similar Himalayan plateau, and if there were as strong an indraught producing southerly winds on our southern borders as on the southern border of Asia, we should still fail to have a strong moist southwest monsoon with rain, because our southern border is separated from the equatorial portion of the Pacific to the southward by the great tablelands of Mexico and Central America. Whatever southwest winds could be produced on our southern borders by monsoon indraught might bring rain to the Pacific coasts of Mexico and Central America, but would then descend to our lower lands, and therefore be dry winds and fail to bring rain to Texas and New Mexico.

Practically, however, there is very little tendency to southwest monsoon winds, partly because the larger part of North America lies in more northerly latitudes contrasted with Hindostan and Farther India, but principally because of the distribution of the highlands. The Asiatic plateau is compact and oval, but the American plateau stretches north and south, relatively long and narrow. The system of pressures, temperatures and winds encircling the earth under the northern and southern tropics or symmetrical therewith, as in the ideal frictionless system first treated of by Ferrel, is, in the case of the actual earth, replaced by systematic departures therefrom constituting oceanic and continental areas. During the summer season, when an oval area of low pressure develops in central and southern Asia, there develops in the United States a trough of low pressure extending from the Gulf of California over Arizona north-northeastward into Alberta. The low pressure in southern Asia extends east and west, and so completely overpowers the general circulation as to obliterate the equatorial trough of low pressure and the equatorial system of winds and calms over the ocean to the south of Asia. The low pressure of the American or Rocky Mountain trough is not so well marked, but is able to overpower the tropical belt of high pressure and divide it into the Atlantic and Pacific high areas. Occasionally it stretches southward beyond Arizona and northward beyond Montana, and appears like an extension northward of the equatorial belt of low pressure. The Indian monsoon causes a portion of the equatorial belt to completely disappear, but the United States monsoon causes a portion of this belt to be merely distorted greatly toward the north. During the summer there is an uninterrupted flow of air over the Indian Ocean from the high pressure of latitude S. 30° to the low pressure of N. 25°; this is the southwest, or summer monsoon of India. In North America during its summer there is a flow of air from both the Atlantic and Pacific tropical high pressures in latitude N. 35° toward, but not around the American trough of low pressure. This latter circulation constitutes the strong northerly winds on the Pacific coast and the southeast winds over the eastern slope of the Rocky Mountains. These two systems of winds are the monsoon features of American climate. It is possible that both these systems rise up and overflow into upper descending currents. As in India, so also in the United States, the monsoon rainfall on the immediate coasts depends primarily upon the temperature, moisture, intensity, and duration of these winds, but in the interior the rain depends on the action of the lower winds, or the ground, upon the upper currents; that is to say, on the so-called topsy-turvy movements. The sliding of the upper over the lower strata under the influence of the rotation of the earth, gives rise to the law discovered and first announced by J. Allan Broun at Makerstoun in 1847, according to whom the successive strata of air as we ascend deflect more and more to the right from the direction of the lower winds. The strength of these lower winds and the depth of the moving layer are the important features in determining the rainfall. If the air rises rapidly near the border of a continent and returns on itself, it is merely a sea breeze; but if it keeps near the ground and penetrates far inward during both day and night, it becomes a monsoon. The stronger the wind at the surface of the ground the greater will be the influence of the irregularities of the earth's surface, and therefore so much the more aerial rolls and waves and whirls, and local clouds and rain will be formed.

The most important topographical feature contributing to the formation of the monsoon, as distinguished from the sea-breeze, is the presence of mountain slopes as was pointed out by Ferrel in his "Popular Treatise on the Winds," art. 132, 134, 136:

132. The strength of the monsoon, or of the land and sea breeze, depends very much upon the nature of the surface of the continent. In the case of a perfectly flat continent, with no highlands or mountain ranges, there would, of course, be an interchange of air between it and the ocean in case of difference of temperature; that of the lower part moving toward the warmer region and that of the upper part away from it; but the monsoon effects would be comparatively small, and would not at all have the great strength of surface which is usually observed. The interchange would be mostly in the great mass of air above, and no strong motion would take place at the earth's surface. In this case, also, the land and sea breezes have but little strength and are felt near the coasts only, but they are very much increased in strength and are felt at a much greater distance, where there are hillsides and mountain slopes near the coast.

In the annual and diurnal oscillations of temperature the amplitudes are small on the ocean surface and in the air at all altitudes above it, and also in the great mass of air over the continent, except in a stratum next the earth's surface, of small depth in comparison with that of the whole. The monsoon effects, therefore, depend mostly upon the temperature differences between the continent and the ocean of only a comparatively thin stratum of the atmosphere next the earth's surface, of which the part over the continent is very much heated above, or cooled below, that of the ocean. The temperature differences of such a stratum over a perfectly level continent, even if they were very great, would give rise to very little horizontal disturbance of the atmosphere. If this stratum over the continent were greatly heated, it might give rise to the unstable state from which would result numerous, but very small, local eruptions through the strata above, but no sensible monsoon effects. On the other hand, if it were cooled down to a very low temperature, the increased density would tend mostly to keep it next the earth's surface, and there would be scarcely any tendency to flow away laterally toward the warmer ocean. But if the surface of the continent is convex, or if it has highlands with long slopes, or the interior is in almost anyway considerably elevated above sea level, the tendency in the case of the summer monsoon to flow in from the ocean toward the interior of the continent, or the reverse in that of the winter monsoon, is very much increased. The same is true with regard to land and sea breezes where there are mountain elevations near the coast.

134. There is also another consideration in connection with the subject of the monsoon influence of highlands. The tendency of air to ascend or descend and to give rise to ascending or descending currents depends upon differences of temperature between the air and that of the surrounding regions at the same level; but it is a matter of observation that the temperature of highlands, and especially of high plateaus, in summer, is nearly as great as that on plains near sea level. The temperature, also, for the altitudes above the surface, at least to a considerable height, must be much greater than that of the surrounding air at the same levels, since the rate of decrease of temperature with increase of altitude above the surface of the plateau is somewhat the same as above any plain near sea level. If a portion of air, therefore, either on a horizontal plane or a slope near sea level is only a little warmer than the surrounding air on the same level, it tends to ascend and to give rise to an ascending current; but if the air at this same temperature is high up on some mountain side or plateau, this tendency is much increased, because now the difference of temperature between this air and the surrounding air at a distance on the same level is much greater.

If a tall flue with a temperature only a little raised above the surrounding temperatures at sea level were elevated to the top of a high mountain, where the surrounding air is much colder and more dense, the draught of the flue would be very much increased. So the wide column of air of higher temperature over a high plateau and extending up to a considerable height above the surface has a much greater tendency to ascend than a similar one of the same temperature on a low plane near sea level.

This effect, however, is felt mostly in the summer monsoon influence, for in winter the temperature of the plateau is not so much below surrounding temperatures as it is above them in the summer.

136.—In the case of the summer monsoon, where the interior of the country is so elevated that the current ascends the slopes to an altitude where condensation of the vapor takes place, the latent heat of condensation adds much strength to the current, just as in the case of the trade winds, in which their strength is increased by the latent heat of condensation in the equatorial rain belt. On this account the summer monsoon of the North Indian Ocean is much stronger than the winter monsoon, so much so, that the southwest monsoon is often spoken of as "the monsoon," the northeast monsoon being insignificant in comparison with it. Notwithstanding that the (northeast) trade wind is combined with the monsoon effect, the resultant of both produces in the Arabian Sea only a gentle and steady breeze during the winter season; whereas the southwest monsoon of the summer is a steady gale of so great strength that it is impossible for even steamers to force a passage from Bombay to the Gulf of Aden in June and July.

In all cases, also of extraordinarily strong sea breezes, there are high mountain elevations near the coast on which there is a vast amount of condensation and precipitation of rain at the time.

The differences of pressure observed on the earth's surface are largely dynamic results, depending on the motion of the air and the centrifugal forces that are evoked by that motion; the high and low barometric areas shown by our isobars are the results of movements in the atmosphere, but are not the direct cause. The ultimate cause of currents and winds must always be found in abnormal densities due, primarily, to the peculiarities in the distribution of temperature and moisture; in the free atmosphere the differences in density have a slight influence on the pressure, but the resulting motions give rise to the larger phenomena of our barometric areas. An increase of density in the tropical high areas off our Atlantic and Pacific coasts will cause them both to push southward; a diminution of density over the American continent will have the same tendency. An equal change in the densities of all three regions will produce no effect on their relative locations; the differential change is that which determines the wind and the overflow, and hence, the observed variations in the locations of these high and low areas. A high area does not push a low area but feeds it.

The southerly current in our Gulf States and the southeast winds on our Atlantic coast are far less steady and much shallower and drier than the southwest monsoon of India, and they proceed inward to a less distance, so that the rainfall depending upon them is correspondingly less. The rains that fall in the United States, both in summer and winter, east of the Rocky Mountains, are largely due to the underflow of cooler air that characterizes the southwest and southeast sides of cyclonic circulations, moving successively across the continent. Even the so-called local summer thunderstorms are often a part of such systems of underflow and uplift.

A long-range prediction as to the quantity and character of the rains during the summer time in the United States must depend upon the possibility of predicting (1) the position of the tropical area of high pressure that encroaches on our south Atlantic States, and (2) the flow of cold, dry air southward from the British possessions that occurs when the tropical high area off of our Pacific States retreats to the west of its average position so that the flow of warm, dry air that descends from it down the eastern Rocky Mountain slope is at a minimum.

Probabilities as to rainfall may be computed from statistics, but a rational prediction must be based on the above mechanical considerations.

AN ITEM IN THE EARLY HISTORY OF WEATHER TELEGRAPHY.

In 1844 (May 27) the Morse system of electro-magnetic telegraph was first put into operation between Baltimore and New York, and it is said that but a few days had elapsed before the operators at either end, in their familiar conversation with each other, began to interchange remarks about the weather and could sometimes forewarn each other of the more important changes. Of course, in those days, as now, the weather, especially the storms, was a matter of news for the daily papers. In 1846, W. C. Redfield, of New York, who had, for twenty-five years, been mapping and studying the progress of storms, published the following sentence in the American Journal of Science and Arts, Vol. II, p. 334:

In the Atlantic ports of the United States, the approach of a gale, when the storm is yet on the Gulf of Mexico, or in the Southern or Western States, may be made known by means of the electric telegraph, which probably will soon extend from Maine to the Mississippi. This will enable the merchant to avoid exposing his vessel to a furious